INSTRUCTION MANUAL

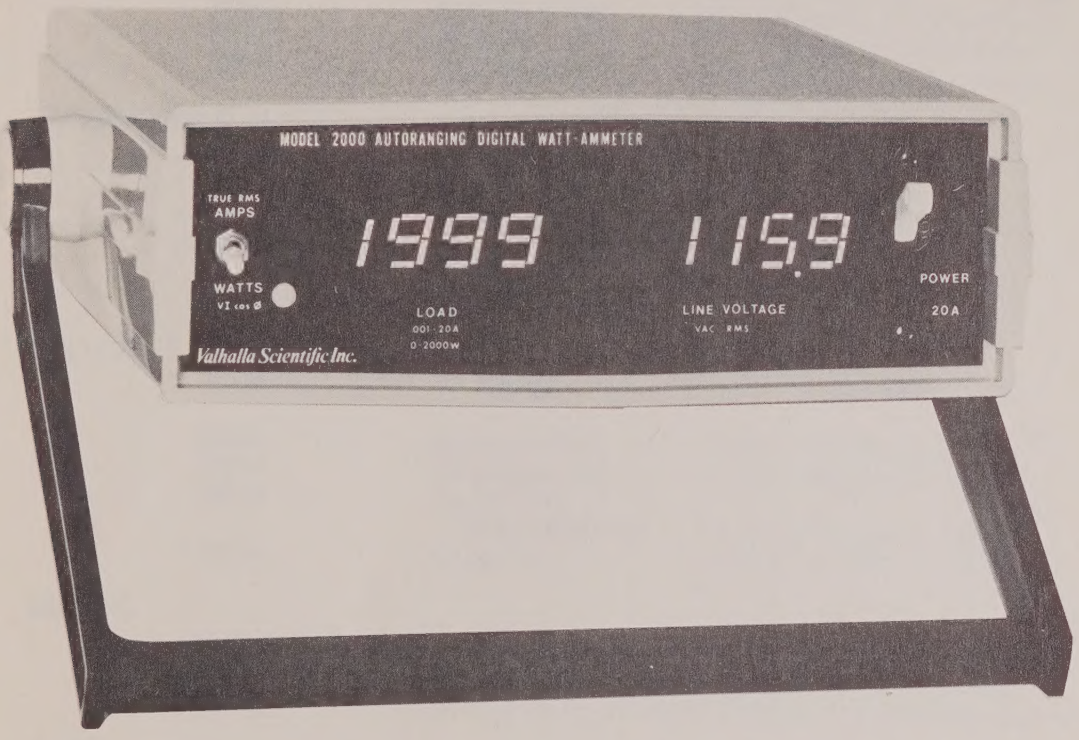
MODEL 2000

CERTIFICATION

Valhalla Scientific Inc. certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. Valhalla Scientific Inc. further certifies that its calibration measurements are traceable to the National Bureau of Standards to the extent allowed by NBS's calibration facility.

WARRANTY

Vallhalla Scientific, Inc. warrants this instrument against defects in material and workmanship for one year from date of shipment. We will repair or replace the instrument during the warranty period provided it is returned to Valhalla Scientific Inc. No other warranty is expressed or implied. We are not liable for consequential damages. Permission must be obtained directly from the factory for warranty repair returns. No liability will be accepted if returned without such permission.



MODEL 2000
AUTORANGING DIGITAL
WATT-AMMETER

SPECIFICATIONS

WATTS

Model No.	Ranges	Accuracy
2000-1	20.00, 200.0, 2000	±0.15% of Reading ±0.15% of Range.
2000-2	20.00, 200.0, 2000	±0.15% of Reading ±0.15% of Range.
2000-3	20.00, 200.0, 2000	±0.3% of Reading ±0.3% of Range.
2000-4	0.2, 2, 20 Kilowatts	±0.5% of Reading ±0.5% of Range.

CURRENT (True RMS)

Ranges:	0.2, 2, 20 Amperes RMS.
Accuracy:	±0.1% of Reading ±0.15% of Range.
Max. RMS Input.	20 Amperes (Circuit Breaker Protected except 2000-4).
Crest Factor:	From 1.75:1 (35 Amps. Peak at 20 Amps. RMS) to 350:1 (35 Amps. Peak at 0.1 Amps RMS).
Shunt Impedance:	0.01 Ohms constant.

VOLTAGE

Model No.	Range	Accuracy
2000-1	90.0 to 140.0 VAC	±0.25% of Reading ±2 Digits.
2000-2	180.0 to 280.0 VAC	±0.25% of Reading ±2 Digits.
2000-3	0 to 199.9 and 100.0 to 299.9 VAC	±0.25% of Reading ±2 Digits.
2000-4	0 to 600 VAC	±0.25% of Reading ±2 Digits.

GENERAL

Watts/Amps Ranging:	3 Automatic Ranges - up range at 2000, down range at 0.180.
Voltage Ranging:	Manual range switch on rear panel, 2000-3 and 2000-4 only.
Display:	2 sets of LED's - 0 to 299.9 for Voltage, 0 to 1999 for Watts-Amps.

POWER

2000-1	90 to 140 VAC, 50 to 60 Hz, 5 watts.
2000-2	180 to 280 VAC, 50 to 60 Hz, 5 watts.
2000-3	115/230 VAC ±20%, 50 to 60 Hz, 5 watts.
2000-4	115/230 VAC ±20%, 50 to 60 Hz, 5 watts.

SIZE

8.5 in. by 9.25 in. by 2.5 in.
(21.6 cm. by 23.5 cm. by 6.4 cm.).

WEIGHT

5 lbs. net, 10 lbs. shipping.

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SECTION I

GENERAL INFORMATION

1-1 DESCRIPTION

1-2 Valhalla Scientific's Model 2000 Auto Ranging Digital Watt-Ammeter was designed as an accurate, low-cost instrument to aid engineering, production test and quality assurance departments in the determination of product power consumption from AC power lines. The instrument features dual, independent digital displays. One provides a continuous display of the AC line voltage. The other is switch selectable between true watts (VI cosθ) and true RMS current.

1-3 The Model 2000 provides a fast and convenient method of determining product efficiency, power factor and true RMS current while continuously monitoring the AC line voltage. Phase angle relationships may be accurately calculated through utilization of the displayed digital data.

1-4 The Model 2000 uses a unique four-quadrant complex waveform analog multiplier to derive a DC signal equivalent to the integrated product of the instantaneous value of line voltage and current. The resultant wattage value is converted for presentation on a 3-1/2 digit display. Automatic ranging provides maximum resolution from 10 milliwatts to 1999 watts. True RMS current from 100 ua through 19.99 amperes with a crest factor of 3:1 may be monitored by selecting the current display with the front panel switch. A conventional 3-terminal power outlet is provided on the rear panel for ease of load connection for 115 volt applications. At time of order, and on request, the standard 15 ampere line cord connector and rear panel connectors of the 115V model will be replaced with 20 ampere, polarized connectors for use with appropriately wired outlets.

1-5 The Model 2000-2 is designed for use on 230V power lines. The input voltage and internal electronic voltage are the same and are connected via a rear panel barrier strip. The 2000-3 version is designed to operate from selectable 115/230V AC independently of load power. The load voltage may be varied from 0 to 300 volts in two ranges; 0 to 199.9 and 100.0 to 299.9. Both input voltage and load are connected via a rear panel barrier strip. The model 2000-4 is designed to operate the internal electronics from 115/230V AC independently of the load. The input voltage may be varied from 0 to 600 volts. Both the input voltage and load are connected via a rear panel barrier strip.

1-6 ACCESSORIES

1-7 The Digital Watt-Ammeter is shipped from the factory with an attached power cord and an instruction manual. Models destined for Europe are supplied with barrier strips for both power and load connections.

1-8 RACK MOUNT - OPTION 'R'

1-9 The Model 2000 may be purchased with an Option 'R' rack mount adapter for use in rack mount applications.

1-10 OPTION BCD

1-11 This option provides BCD data outputs from the Model 2000 that are optically isolated and suitable for input to a dual limit comparator such as the Valhalla Model 1248. This option, in conjunction with the Model 1248, permits rapid production line testing of wattage consumption with visual indication and optional electrical outputs whenever the wattage or current delivered to the load falls outside the upper or lower preset limits.

1-12 20 AMPERE LOAD EXTENSION CORD

1-13 A 2-foot extension cord with 20 ampere capacity is available as an option. This allows the operator easy access to the rear connector by effecively bringing it around to the front work area.

SECTION II

INSTALLATION

2-1 INTRODUCTION

2-2 This section of the manual contains information for inspection and installation of the Model 2000 Digital Watt-Ammeter.

2-3 INITIAL INSPECTION

2-4 If the external shipping container shows evidence of in-transit damage, such damage should be immediately brought to the attention of the carrier and such damage noted on the bill of lading.

2-5 Unpack the instrument and retain the shipping container until the instrument has been inspected for possible damage in shipment. If in-shipment damage is observed, notify the carrier and obtain his authorization for repairs before returning the instrument to the factory. Where the external shipping container has shown evidence of damage in transit, but the instrument shows no external damage, it may be advisable to perform the calibration procedure of Section V to determine that the instrument has not incurred hidden damage.

2-6 POWER REQUIREMENTS

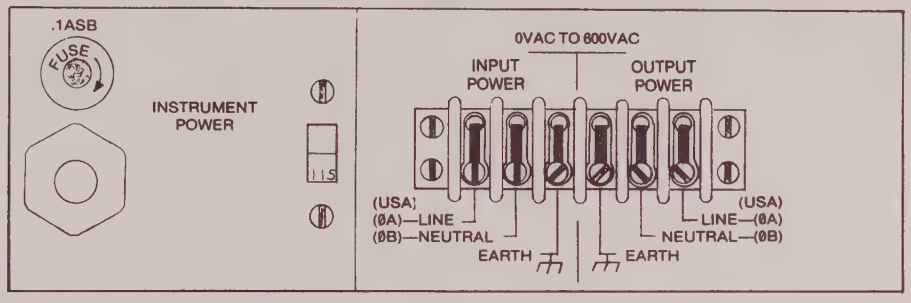
2-7 The instrument is shipped from the factory for operation from the power source voltage specified by the purchaser. The unit is available for operation at 115V, 15 Amps Max.; 115V, 20 Amps Max.; or 230V, 20 Amps Max. Connectors designed for 115V-20 amp (NEMA 5-20) operation use different blade configurations than connectors designed for 115V-15 amp operations. The Model 2000-1 is shipped from the factory with the standard 15 amp power cord. If the customer desires 20 amp operation, Valhalla will supply the 20 ampere connector at no charge. Please contact Valhalla Customer Service department if you require a 20 amp connector. Refer to paragraph 1-5 for additional voltage connector information for other models. All units operate from 50-60 Hz input. Units connected for 115V operation will operate at line voltages of 90 to 140 volts. Those configured for 230 volt operation will operate at line voltages of 180 to 280 volts. The power cord and rear panel connections are identified to assist the operator in properly connecting the unit and load to voltages and current sources for which they are rated. The power cord is permanently attached in all but the 2000-2 model.

2-8 INSTALLATION

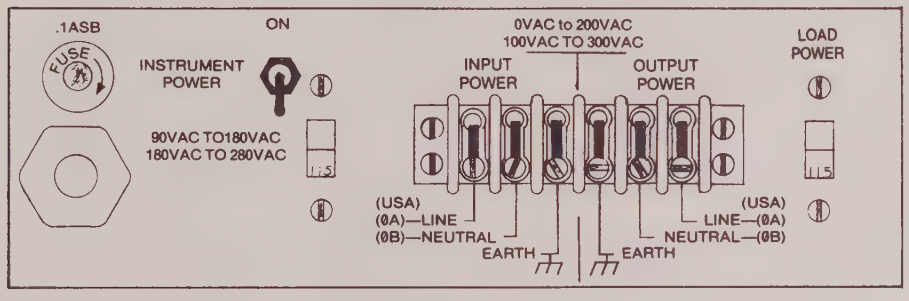
2-9 If the Model 2000 is to be used in the bench top configuration, installation requires only that the power input be connected to the wall receptacle and that the load under test be connected to the rear panel connector. On all models, except the 2000-4, the front panel circuit breaker switch controls power to the internal circuits and the rear panel receptacle. (The 2000-4 does not use a circuit breaker).

2-10 If the Watt-Ammeter is to be installed in a rack, assemble the unit into the rack mount adapter. Then it is only necessary to locate the unit in the rack, install the screws that attach it to the rack and make the power cource and load connections. The unit should be operated only in areas where the ambient temperature does not exceed 50°C. If the internal temperature of the rack mount, in which the unit is installed, will exceed this temperature limit, forced air cooling whould be employed to maintain the ambient air at or below the 50°C limit.

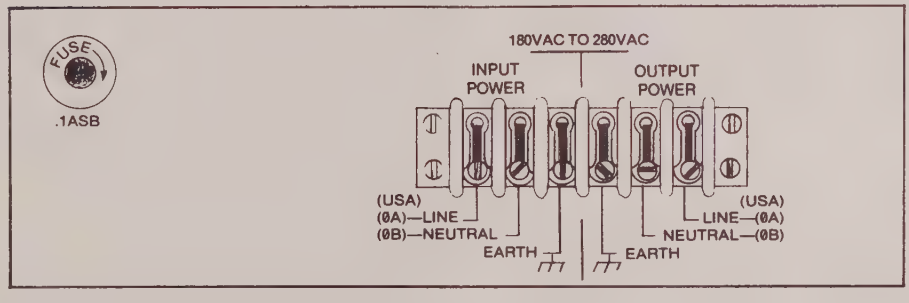
2000-4



2000-3



2000-2



2000-1

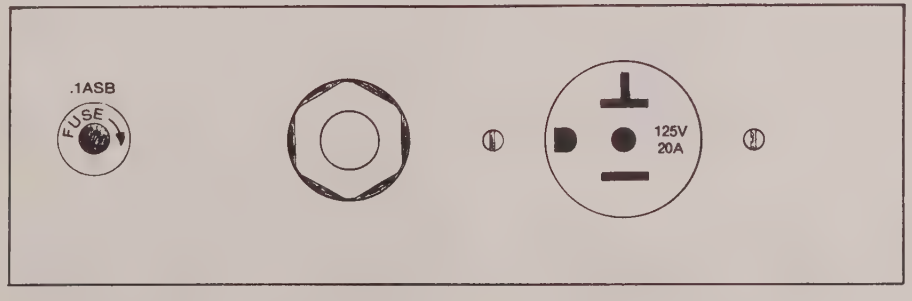


Figure 1. Rear Panel Connections.

SECTION III

OPERATION

3-1 INTRODUCTION

3-2 This section of the manual contains complete operating instructions for the Model 2000 Digital Watt-Ammeter.

3-3 FRONT PANEL CONTROLS AND INDICATORS

3-4 There are two switches on the front panel of the Models 2000-1, 2000-2 and 2000-3. The 20 ampere circuit breaker functions as load protection for all three models and is the power ON/OFF control for Models 2000-1 and 2000-2. The Model 2000-3 has a rear panel ON/OFF switch. The Model 2000-4 uses a power ON/OFF toggle switch on the right side of the front panel. Application of power to the instrument is indicated by lighting of the LINE VOLTAGE and LOAD displays. The other switch selects the indicating mode of the LOAD display. When in the WATTS position, the LED indicator adjacent to the WATTS legend is illuminated and the indication in the LOAD display is the true VI cosθ power to the load. When the switch is in the AMPS position, the LED indicator adjacent to the AMPS legend is illuminated and the indication in the LOAD display is the true RMS current flowing to the load. Each display is composed of 3-1/2 seven-segment digits.

3-5 VOLTMETER

3-6 The LINE VOLTAGE display will show the line voltage at all times with 0.1 volt resolution regardless of the mode of the LOAD display. The Model 2000-4 display is for a 1000V range which limits the resolution to 1 volt. Operation of the instrument is specified from 90 to 140 volts for the 115V model and from 180 to 280 volts for the 230V model. The Model 2000-3 operates from 0 to 199.9V AC and from 100.0 to 299.9 for load testing. The operating input voltage may be selected with a rear panel switch for 115 or 230V AC. A second rear panel mounted slide switch permits selection of load power range.

3-7 AMMETER

3-8 To operate the Model 2000 in the AMPS mode, place the AMPS/WATTS switch in the AMPS position. The 3-1/2 digit LOAD display then indicates the current flowing to the load. There are three current ranges, 0.2A, 2A and 20A. Ranging is fully automatic. Whenever the input to the instrument is such that the indication would be 0180, or less (decimal point omitted), the instrument will automatically downrange. Whenever the input is such that the indication would be more than 1999, the instrument automatically upranges. If the maximum current of 19.99 amperes is exceeded, the display will blink until the load is removed or the current is reduced to within the instrument's range. If the indication is .0180 amperes, or less, the instrument is already operating in its lowest range (0.2A).

3-9 The foregoing paragraph was based on sinusoidal or near-sinusoidal waveforms. Under conditions of pulsing, or other complex waveforms with large crest factors, the instrument will uprange as necessary to maintain the input signal within the linear operating range of the internal amplifier. This insures that the display indication is in terms of the true RMS value of the measured current. Accuracy is not impaired. However, the reading resolution will be reduced. For example, if the true RMS value of a sinusoidal current is near 1.2 amperes, the display might indicate 1.212 amps. If the current is a high crest factor waveform, and it is necessary to uprange, the reading for the same RMS value would be 01.21. This feature is an invaluable aid to the test personnel as the leading zero to the left of the decimal point provides an recognizable indication that the current is other than near-sinusoidal and has a high crest factor, in the area of 3:1 or more.

3-10 WATTMETER

3-11 To operate the Model 2000 in the WATTS mode, the AMPS/WATTS switch is placed in the WATTS position. The LED indicator adjacent to the WATTS legend will illuminate to indicate the unit is operating in the WATTS mode. The LOAD display will then indicate the power, in watts, being delivered to the load. This is a true VI cosθ indication irrespective of the voltage or current waveforms. There are three power ranges; 20 watts, 200 watts and 2000 watts except the Model 2000-4 which is has ranges of 0.2, 2.0 and 20 kilowatts. Ranging in the power mode, as in the current mode, is completely automatic. Whenever the power to the load is such as to provide an indication of 0180, or less, the instrument will automatically downrange. If the load power delivered would produce an indication of 1999, or more, the instrument will uprange. If the maximum of 1999 watts is exceeded, the display will blink until the load power is reduced to a value within the range of the instrument or

the load is removed. If the indication is 01.80, or less, the instrument is operating in its lowest range, 20 watts.

3-12 As in the current mode of operation, the foregoing is applicable only when the current flowing to the load is near-sinusoidal. The autoranging system operates in an identical manner in the power mode as in the current mode. When the current is of a pulsing or complex nature, the peak detector will force an uprange to maintain the current amplifier in its linear operational region.

SECTION IV

FUNCTIONAL DESCRIPTION

4-1 GENERAL

4-2 This section of the manual provides a functional description of the Model 2000 Digital Watt-Ammeter referenced in the block diagram of Figure 2. The description provided in this section is intended to assist the engineer or technician in gaining a general understanding of the operation of the circuits of the Model 2000 without the necessity of a detailed circuit description. With the information provided in this section (and that of Section V, Calibration) routine maintenance during the initial one-year warranty period can be accomplished. Detailed warranty maintenance during this period will be accomplished at the factory. A full service manual will be available at a later date so that maintenance on a field basis may be accomplished after expiration of the warranty.

4-3 POWER SUPPLIES

4-4 Power for the internal logic circuits is obtained from a power transformer, rectifier-filter system and regulators. In addition, a precision reference is obtained from the 5 volt logic supply. The reference supply furnishes an input to the voltmeter and current meter circuits to which the line voltage and current are compared.

4-5 VOLTMETER

4-6 The line voltage is sampled by a precision operational rectifier. The resultant DC voltage is passed through a dynamic filter before being applied to the DC Voltmeter circuit. The VOLTS display is driven by a large scale integrated (LSI) circuit that compares the input DC to a precision reference voltage and develops the drive signals for the digit display selector and decoder/driver. The reading on the 3-1/2 digit display has a resolution of 0.1 volt. The displayed voltage is the average value of the line voltage calibrated in RMS.

4-7 The 115V AC model of the Digital Wattmeter will operate with and display line voltages between 90 and 140. The 230V AC model will operate from 180 to 280 volts and line voltages between those limits will be displayed. As shown in the block diagram, the VOLTS voltmeter and its display do not enter into the power computations, but provide information on line voltage conditions to the operator. The displayed voltage is necessary to the calculaton of phase angle and power factor.

4-8 AMMETER

4-9 A 0.01 ohm current shunt resistor in series with the power line neutral, provides the current sense input to the variable gain operational amplfier. The gain of the amplifier has three ranges that are controlled by the autoranging system. The output amplitude of the amplifier is maintained within the input limits of the true RMS converter. The converter develops a DC voltage proportional to the true RMS value of the amplifier output which is in direct relationship to the line current. In the AMPS mode, the output of the true RMS converter is applied to the LOAD display through the AMPS/WATTS selector. The IC and display circuit of the ammeter are similar to those employed in the VOLTS display and use a reference from the same source as that for the VOLTS display.

4-10 The ammeter circuit employs autoranging so that operation of the wattmeter is completely automatic. The LOAD display voltmeter IC used in the ammeter circuit has an overflow output that indicates that the applied input is beyond the measuring range of the IC. This output is used to command the autoranging system to uprange one step. The autoranging system output then reduces the gain of the variable gain amplifier to bring the output of the true RMS converter within range of the IC input. Current inputs that would cause a reading of 0180, or less, cause the autoranging system to downrange. There are three ranges of current; 0.2, 2 and 20 amperes. If the current exceeds 19.99 amperes, the system cannot uprange further. The display will read 19.99, but it will be blinking to indicate the overrange condition.

4-11 The Model 2000 is designed to provide true RMS current and true wattage (VI cosθ) readings with current and voltage waveforms that may be distorted severely compared to a sinusoidal waveform. In cases where peak currents are several times greater than the true RMS value, the input to the LOAD display may be within range, but the variable gain amplifier will be operating in its non-linear region. Therefore, the peak detector provides an input to the autoranging system that forces an uprange whenever the peak current is greater than 3.5 times the range. At the same time, it inhibits a downrange from being forced by the LOAD display input. Such a condition is indicated by a display reading of 01.00, for example, rather than 1.000, which would be the normal indication for a sinusoidal current.

4-12 WATTMETER

4-13 In the wattmeter mode, the DC output of the true RMS converter is removed from the LOAD display input and the output of the four-quadrant analog multiplier is connected to the LOAD display input. The analog multiplier multiplies the current input times the voltage input and provides a DC voltage output proportional to VI cosθ. This DC voltage is then applied to the LOAD display IC to produce the wattage reading. The analog multiplier is an integrated circuit configuration that permits the connection of non-linearties and auto-zero functions thereby providing the high accuracy of the instrument in the wattmeter mode.

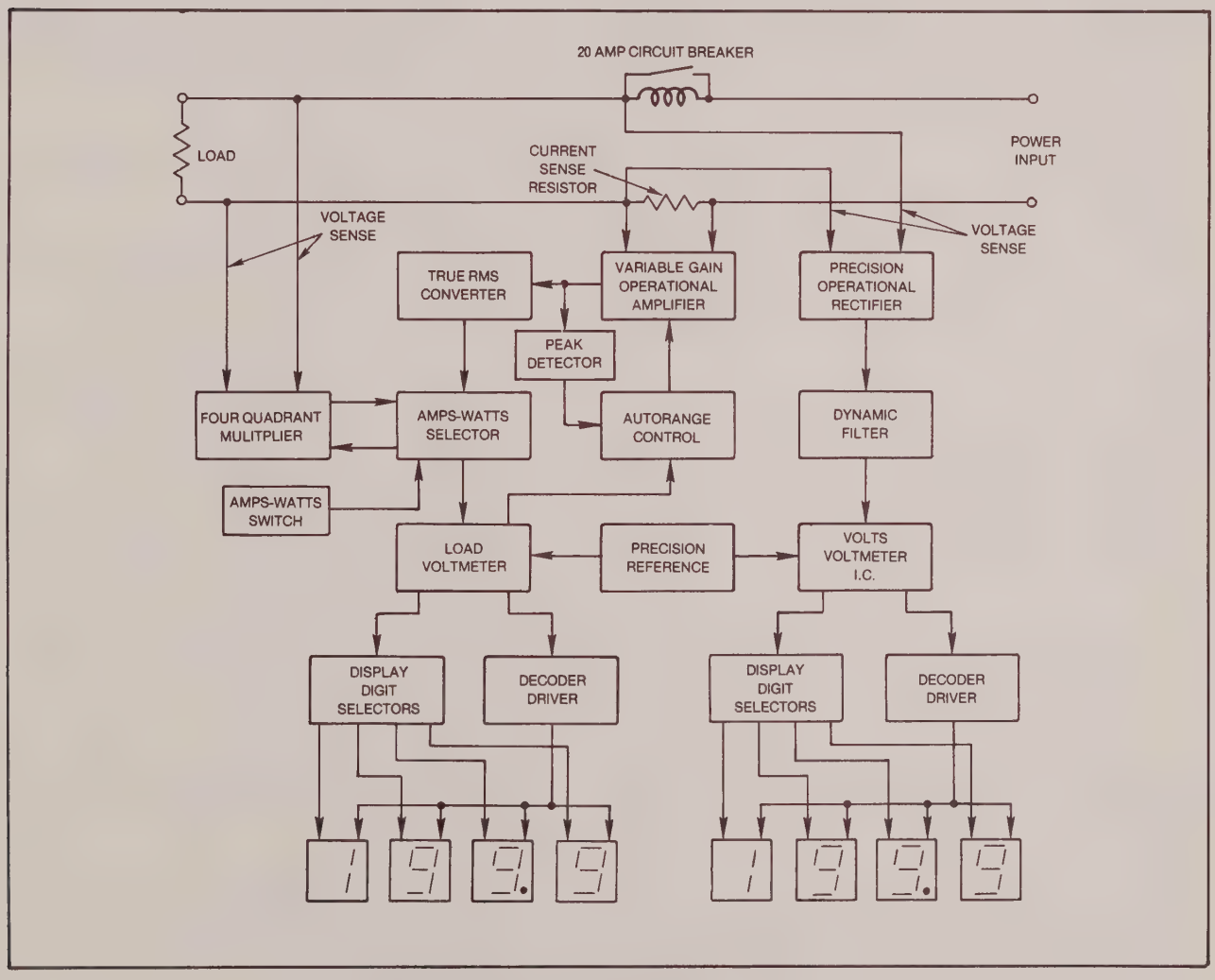


Figure 2. Block Diagram, Model 2000 Watt-Ammeter.

SECTION V

MAINTENANCE

5-1 INTRODUCTION

5-2 This section contains the maintenance information for the Valhalla Scientific Model 2000 Series Digital Watt-Ammeters. Included in this section are the required test equipment list and calibration procedures.

5-3 REQUIRED TEST EQUIPMENT

5-4 The test equipment required for maintenance and calibration of the Vallhalla Model 2000 Series Digtial Watt-Ammeters is listed below:

Wattmeter Calibrator	Valhalla Model 2720
Precision Current Source	Valhalla Model 2510

5-5 CALIBRATION PROCEDURE

5-6 The following procedure should be performed on a routine basis to insure that the instrument remains within calibration limits. The calibration procedure should be performed before returning the unit to service after repairs have been accomplished that involve any of the accuracy determining components.

NOTE

Calibration adjustments and locations are identified in the Assembly Diagram, Figure 5-1.

5-7 Connect the voltage output from the Model 2720 Wattmeter Calibrator to the power input on the Model 2000. No output load should be connected to the Model 2000.

5-8 Set the Model 2710 to 60 Hz and select the desired output voltage. (120V AC for the Model 2000-1, 240V AC for the Model 2000-2, 120V AC for the Model 2000-3, and 500V AC for the Model 2000-4).

5-9 Adjust R35 for the desired indication.

5-10 On the Model 2000-3 only, change rear panel selector switch position to 230V mode and apply 230V AC. Adjust R63 for desired indication.

5-11 Set the Model 2720 output to zero, Connect output of the Model 2510 Current Source from the line neutral input to line neutral output (LO output to line neutral input).

NOTE

On the Model 2000-1, remove the top cover and connect the Model 2720 input across the outside ends of the rear panel current shunt. The 2510 high output connects to the LOAD side of the shunt.

5-12 Set the 2720 to the desired line voltage and set th 2510 to 100.00 milliamperes.

5-13 Set the front panel AMPS/WATTS selector switc to the AMPS position.

5-14 Adjust R4 for an indication of .1000 AMPS.

5-15 Set the Model 2510 to output to 1.0000 amps.

5-16 Adjust R3 for an indication of 1.000.

5-17 Set the Model 2510 output to 10.000 amps.

5-18 Adjust R2 for an indication of 10.00.

5-19 Set the Model 2510 output to 0.

5-20 Select the WATTS function on the Model 2000.

5-21 Connect a FLOATING DVM to IC4, pin 6.

5-22 Vary R20 for +1V and -1V DC indication on the DVM and set R77 for less than a 2-digit change in the WATTS reading.

5-23 Set R20 for a reading of less than +0.1V DC on the DVM. Disconnect the DVM.

5-24 Adjust R67 for an indication of 00.00 on the WATTS display.

5-25 Set the Model 2720 for a POWER FACTOR of 1.00 and a WATTS output of 1000.

5-26 Adjust R11 for an indication of 1000.

5-27 Set the Model 2720 POWER FACTOR to .50. The Model 2000 read 500, ±2 digits.

5-28 Set the Model 2720 POWER FACTOR to .00. The Model 2000 should read 000, ±2 digits.

NOTE

The absence of a decimal indication during the step of 5-28 demonstrates that the instrument remained on the 2000 WATT range. If the instrument downranged during this test (00.0) this would indicate a malfunction in the high crest factor range circuitry.

5-29 R34 need not be adjusted unless R2, R3 and R4 are outside their dynamic range.

5-30 R36 and R44 control the clock frequency of the two A-D converters and need not be adjusted on a routine basis.

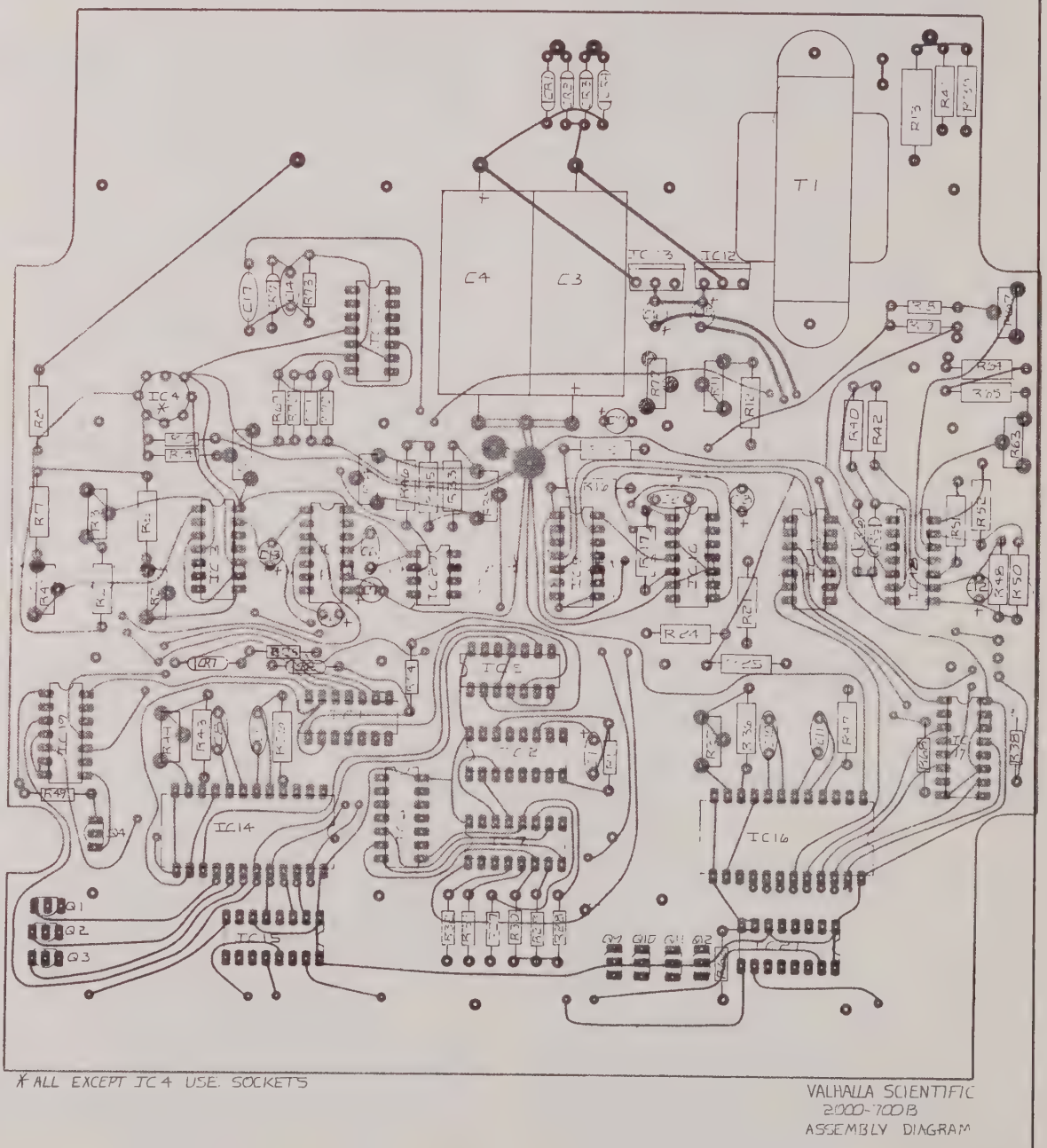


Figure 3. Circuit Board Assembly Diagram.

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PARTS LIST

REF. DES.	V.S. P/N	DESCRIPTION	MFG.	MFG. P/N
C1	2-30004	Cap, Tan 1μf/10V	05397	T360B105M01AS
C2	2-10006	Cap, Cerm .01μf/100V	56289	5GAS10
C3, 4	2-40008	Cap, Elec 500μf/50V	56289	TVA-1315
C5	2-30008	Cap, Tan 6.8μf/10V	05397	T360B685M010AS
C6	2-20009	Cap, Mica 470Pf	81349	CM05FD471J03
C7	2-30007	Cap, Tan 2.2μf/10V	05397	T360B225M010AS
C8, 9, 10, 11, 14, 17	2-60002	Cap, Paper .1μf/100V	56289	225P10491
C12, 15, 16	2-30001	Cap, Tan 10μf/10V	05397	T360B106M025AS
C13	2-30003	Cap, Tan 47μf/10V	05397	T360B476M010AS
C18, 19	2-30000	Cap, Tan 4.7μf/10V	05397	T360B475M025AS
CR1-4	3-20002	Diode	07263	1N4001
CR5-8	3-20000	Diode	07263	1N914
CR9	3-20008	Diode, H.C.	07263	FH1100
DS1-8	5-01010	Led 0-9 Display	28480	5082-7650
DS9, 10	5-01005	Led Red	Monsanto	MV5074
IC1, 11	3-30027	IC Quad Nand	86684	CD4011BE
IC2	3-30068	IC Up/Dn Counter	27014	CD40193BE
IC3	3-30023	IC Quad Switch	86684	CD4066BF
IC4	3-30030	IC Fet Op Amp	27014	LH0042CH
IC5, 19	3-30026	IC Dual D Flip Flop	86684	CD4013BE
IC6	3-30055	IC Quad OR	27014	CD4071BE
IC7	3-30050	IC Dual 1 of 4	86684	CD4555BE
IC8	3-30045	IC RMS to DC Conv	A.D.	AD536JD
IC9	3-30065	IC Sample and Hold	53504	3-30065
IC10	3-30066	IC Analog Multiplier	53504	3-30066
IC12	3-30035	IC Voltage Reg (Neg)	27014	LM320T-5.0
IC13	3-30034	IC Voltage Reg (Pos)	27014	LM340T-5.0
IC14, 16	3-30062	IC LSI	04713	MC14433P
IC15, 21	3-30063	IC Decoder Driver	04713	MC14543BCP
IC18, 22	3-30070	IC Quad Fet Op Amp	01295	TL084CN
IC20	3-30064	IC Reference	04713	MC1403
IC17	3-30052	IC Quad 2 Line-to-1 Line	04713	CD40257B
Q1-12	3-10003	Transistor NPN	04713	2N5172
R1	1-01081	Res Fxd 100K 1/4W 5%	81349	RC07GF104J
R2	1-50004	Res Var 500Ω	71450	X201R501
R3	1-50003	Res Var 5K	71450	X201R502
R4, 20, 67	1-50005	Res Var 50K	71450	X201R503
R5	1-10073	Res Fxd 9.76K 1%	81349	RN60C9761F
R6	1-10074	Res Fxd 97.6K 1%	81349	RN60C9762F
R7	1-10075	Res Fxd 976K 1%	81349	RN60C9763F

Valhalla Scientific Inc

PARTS LIST

REF. DES.	V.S. P/N	DESCRIPTION	MFG.	MFG. P/N
R8	1-10001	Res Fxd 1K 1%	81349	RN60C1001F
R9	1-20040	Res Fxd .01Ω	53504	1-20040
R10, 19, 59-61, 66	1-01041	Res Fxd 1K 1/4W 5%	81349	RC07GF102J
R11	1-50015	Res Var 2.5K	71450	X201R252
R42	1-10083	Res Fxd 2.491K 1%	81349	RN60C2491F
R48	1-10082	Res Fxd 11K 1%	81349	RN60C1102F
R73	1-01112	Res Fxd 5.1M 1/4W 5%	81349	RC07GF515F
R27-32, 75, 74	1-01061	Res Fxd 10K 1/4W 5%	81349	RC07GF103J
R17	1-10006	Res Fxd 100K 1%	81349	RN60C1003F
R22, 23, 62	1-01051	Res Fxd 3.9K 1/4W 5%	81349	RC07GF392J
R24	1-10028	Res Fxd 24.9K 1%	81349	RN60C2492F
R25	1-10020	Res Fxd 499K 1%	81349	RN60C4993F
R26, 47	1 10059	Res Fxd 475K 1%	81349	RN60C4753F
R33	1-10060	Res Fxd 3.92K 1%	81349	RN60C3921F
R34, 35, 63, 77	1-50000	Res Var 100Ω	71450	X201R101
R36, 43	1-10057	Res Fxd 294K 1%	81349	RN60C2943F
R37, 44	1-50011	Res Var 10K	71450	X201R103
R39, 41	1-10007	Res Fxd 1M 1%	81349	RN65C1004F
R15, 16, 21, 50, 52	1-10008	Res Fxd 10K 1%	81349	RN60C1002F
R40	1-10061	Res Fxd 4.99K 1%	81349	RN60C4991F
R45	1-10058	Res Fxd 909Ω 1%	81349	RN60C9090F
R46, 64		Factory Select		
R49	1-01045	Res Fxd 2K 1/4W 5%	81349	RC07GF202J
R51, 65	1-10078	Res Fxd 2K 1%	81349	RN60C2001F
R53-58	1-01048	Res Fxd 2.7K 1/4W 5%	81349	RC07GF272J
R38, 68	1-01073	Res Fxd 47K 1/4W 5%	81349	RC07GF473J
R69	1-01044	Res Fxd 1.8K 1/4W 5%	81349	RC07GF182J
R70	1-01053	Res Fxd 4.7K 1/4W 5%	81349	RC07GF472J
R71	1-01026	Res Fxd 220Ω 1/4W 5%	81349	RC07GF221J
R72	1-01050	Res Fxd 3.3K 1/4W 5%	81349	RC07GF332J
R14, 18	1-01097	Res Fxd 750K 1/4W 5%	81349	RC07GF754F
S1	5-03014	20A Circuit Breaker	74913	JA1-A3-A-20-2
S2	5-03007	SPDT Toggle	95146	MST105D
T1	4-20007	Transformer	53504	4440-011
1 ea	4-10130	Chassis		CH-250 Beige
1 ea	4-10113	Front Panel	53504	2000-205
1 ea	4-30031	PC Board (Main)	53504	2000-700
1 ea	4-30034	PC Board (Display)	53504	2000-701
1 ea	5-10007	Terminal		1300B
2 ea	5-10006	Chassis Fastner		1591B-11
2 ea	5-10042	IC Socket 24 Pin	01295	CS3024B
1 ea		Fuse .1A S.B.		

MODEL: 2000

TITLE: Digital Watt-Ammeter

Valhalla Scientific Inc

PARTS LIST

REF. DES.	V.S. P/N	DESCRIPTION	MFG.	MFG. P/N
5 ea	5-10008	IC Socket 16 Pin	01295	CS3016B
11 ea	5-10041	IC Socket 14 Pin	01295	CS3014B
1 ea	5-10070	IC Socket 8 Pin	01295	CS3008B
15 ea		#4 x 1/4 Lg Self Tapping Screws		
2 ea		#6 - 32 x 1/4" Blk Phl Head		

MODEL:	TITLE:	SHT OF
2000	Digital Watt-Ammeter	3 4

Valhalla Scientific Inc

PARTS LIST

REF. DES.	V.S. P/N	DESCRIPTION	MFG.	MFG. P/N
FOR 2000-1 UNITS				
1 ea	4-10114	Rear Panel	53504	2000-206C
1 ea	5-10018	Fuse Holder		42004A
R12	1-10079	Res Fxd 30K 1%	81349	RN60C3012F
R13	1-10076	Res Fxd 1.5M 1%	81349	RN65D1504F
J1	5-10111	AC Receptacle (125V)	74545	5366-NEMA5-20R
P1	5-10113	AC Plug (125V)	74545	5366-NEMA5-20P
1 ea	5-10119	Strain Relief	LAPP	LAPP SL-11
1 ea	5-10107	Power Cord	70903	17629
2 ea		6-32 x 1/4" Lg ph Blk		
FOR 2000-2 UNITS				
1 ea	4-10148	Rear Panel	53504	2000-208
R12	1-10080	Res Fxd 60K 1%	81349	RN60C6042F
R13	1-10019	Res Fxd 3M 1%	81349	RN65D3004F
1 ea	5-10018	Fuse Holder		42004A
1 ea	5-10130	Barrier Strip	71785	6-140Y
4 ea		6-32 x 1/2" Lg Blk Pg	71185	6-140Y
FOR 2000-3 UNITS				
R12	1-10080	Res Fxd 60K 1%	81349	RN60C6042F
R13	1-10019	Res Fxd 3M 1%	81349	RN65D3004F
1 ea	5-10118	Strain Relief	LAPP	LAPP SL-9
BT1	5-10130	Barrier Strip	71785	6-140Y
S3, 4	5-03017	Slideswitch 115V/230V	82389	46256LFR
1 ea	5-10010	Power Cord	70903	17258-B
1 ea	4-10131	Rear Panel	53504	2000-207
S5	5-03007	SPDT Toggle	95146	MST105D
4 ea		6-32 x 1/4" Lg Blk		
4 ea		6-32 x 1/2" Lg Blk Ph		
FOR 2000-4 UNITS				
1 ea	4-10146	Front Panel	53504	2000-209
1 ea	4-10147	Rear Panel	53504	2000-210
S3	5-03007	SPDT Toggle Switch	95146	MST105D
S4	5-03017	Slide Sw 115/230	82389	46256LFR
1 ea	5-10118	Strain Relief	LAPP	LAPP SL-9
R39, 41, 13	1-10030	Res Fxd 9.9m .1%	CADDOCK	1776-35
1 ea	5-10018	Fuse Holder		42004A
R12	1 10012	Res Fxd 20K 1%	81349	RN60C2002F
1 ea	5-10150	Barrier Strip	71785	6-140Y

MODEL: 2000	TITLE: Digital Watt-Ammeter	SHT 4 OF 4

FEDERAL SUPPLY CODE
for
MANUFACTURERS CATALOGING HANDBOOK H4-1

00001	Monsanto, Electronic Special Products, Cupertino, Calif.
00656	Aerovox Corporation, New Bedford, Mass
00853	Sangamo Electric Company, Pickens, S.C.
01121	Allen-Bradley Company, Milwaukee, Wisc.
01255	Litton Industries, Inc., Beverly Hills, Calif.
01281	T R W Semiconductors, Inc., Lawndale, Calif.
01295	Texas Instruments, Inc., Dallas, Texas
02335	Fairchild Controls Corp., Hicksville, LI, N.Y.
02660	Amphenol Corporation, Broadview, N.Y.
03507	General Electric Company, Syracuse, N.Y.
04713	Motorola Semiconductor Prod., Inc., Phoenix, Ariz.
04963	3-M, St. Paul, Minn.
05276	Pomona Electronics Co., Inc., Pomona, Calif.
05397	Kemet, Union Carbide Corp., Cleveland, Ohio
05820	Wakefield Engineering, Inc., Wakefield, Mass.
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07263	Fairchild Camera and Instr. Corp., Mt. View, Calif.
07716	I R C, Incorporated, Burlington, Iowa
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08065	Accurate Rubber and Plastics Co., San Diego, Calif.
09026	Babcock Electronics Corp., Costa Mesa, Calif.
12405	Hysol Corporation, El Monte, Calif.
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13454	Texas Crystals, River Grove, Ill.
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18722	R C A, Mountaintop, Pa.
21604	Buckeye Stamping Company, Columbus, Ohio
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27014	National Semi-Conductor Corp., Santa Clara, Calif.
27556	IMB Electronic Products, Santa Fe Springs, Calif.
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71450	CTS Corporation, Elkhart, Ind.
71468	ITT Cannon Electric, Inc., Los Angeles, Calif.
71590	Centralab Div., Globe-Union, Inc., Milwaukee, Wisc.
71785	Cinch Manufacturing Company, Chicago, Ill.
73899	J F D Electronics Company, Brooklyn, N.Y.
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88245	Useco Div., Litton Industries, Van Nuys, Calif.
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92194	Alpha Wire Corporation, Elizabeth, N.J.
93332	Sylvania Electric Products, Inc., Woburn, Mass
98978	IERC, Burbank, Calif.
00002	Jordan Electronics, Van Nuys, Calif.
53504	Valhalla Scientific, Inc., San Diego, Calif.

MODEL 2000
AUTORANGING DIGITAL
WATT-AMMETER

ORDERING INFORMATION

MODEL NO.	INPUT VOLTAGE	CURRENT RANGE	POWER RANGE
2000-1	90 to 140 VAC	0 to 20 A	0 to 2000 WATTS
2000-2	180 to 280 VAC	0 to 20 A	0 to 2000 WATTS
2000-2	0 to 300 VAC	0 to 20 A	0 to 2000 WATTS
2000-4	0 to 600 VAC	0 to 20 A	0 to 20 KILOWATTS
OPTION "R"	RACK MOUNT ADAPTER WITH POWER RECEPTACLE		
OPTION "EXT"	24 INCH EXTENSION CORD, 120 VAC, 20 AMP		

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